Calorimeter Simulation Task Force

JetMET

Feb 26, 2008

Frank Chlebana

Calorimeter Simulation Task Force

Full Simulation in ECAL + HCAL

- Evaluate and fix or tweak shower models inside GEANT4 to improve agreement of response with Test Beam data on: *linearity, resolution and shower shapes*
- Implement saturation effect in ECAL and HCAL scintillators
- Implement contribution of Cherenkov light in ECAL response
- Develop a GFlash based parameterization of EM and HAD shower shapes using Test Beam data as an option to improve accuracy

Fast Simulation of Hadronic Shower

- Tune parameterization of EM and HAD shower to full simulation to 1%
- In parallel, tune shower parameterization to available data

Develop strategy to use collider data to tune the full and fast simulation

- Includes development of a trigger list to record the required data as well as the tools for analysis and tuning

Time Scale and Meetings

First meeting was held Feb 15
Next meeting Feb 29 during CMS week

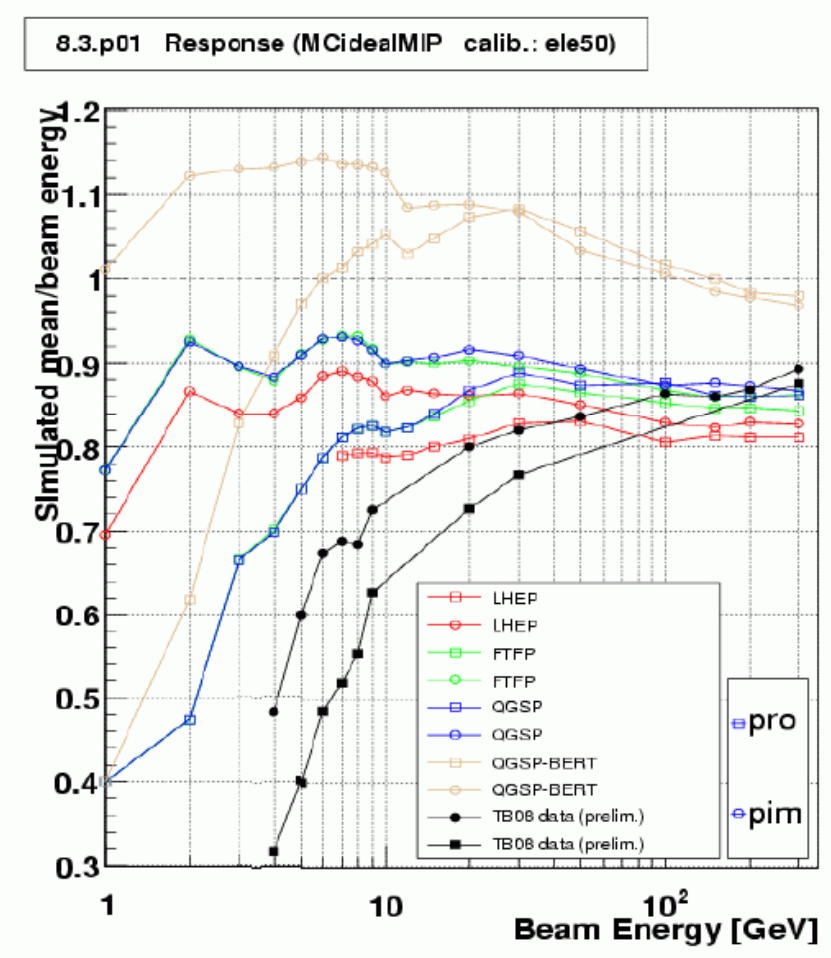
Weekly meetings starting March 7
Using EVO (Calorimeter Simulation Task Force)

Fridays starting at 17:00 (CERN Time)

Meeting room:
CERN 40-R-B10
Fermilab WH6 (Darkside) or WH9 (Libra)

Time Scale: 3 months ending in May

Simulation of Test Beam



Simulation of Test Beam Geometry

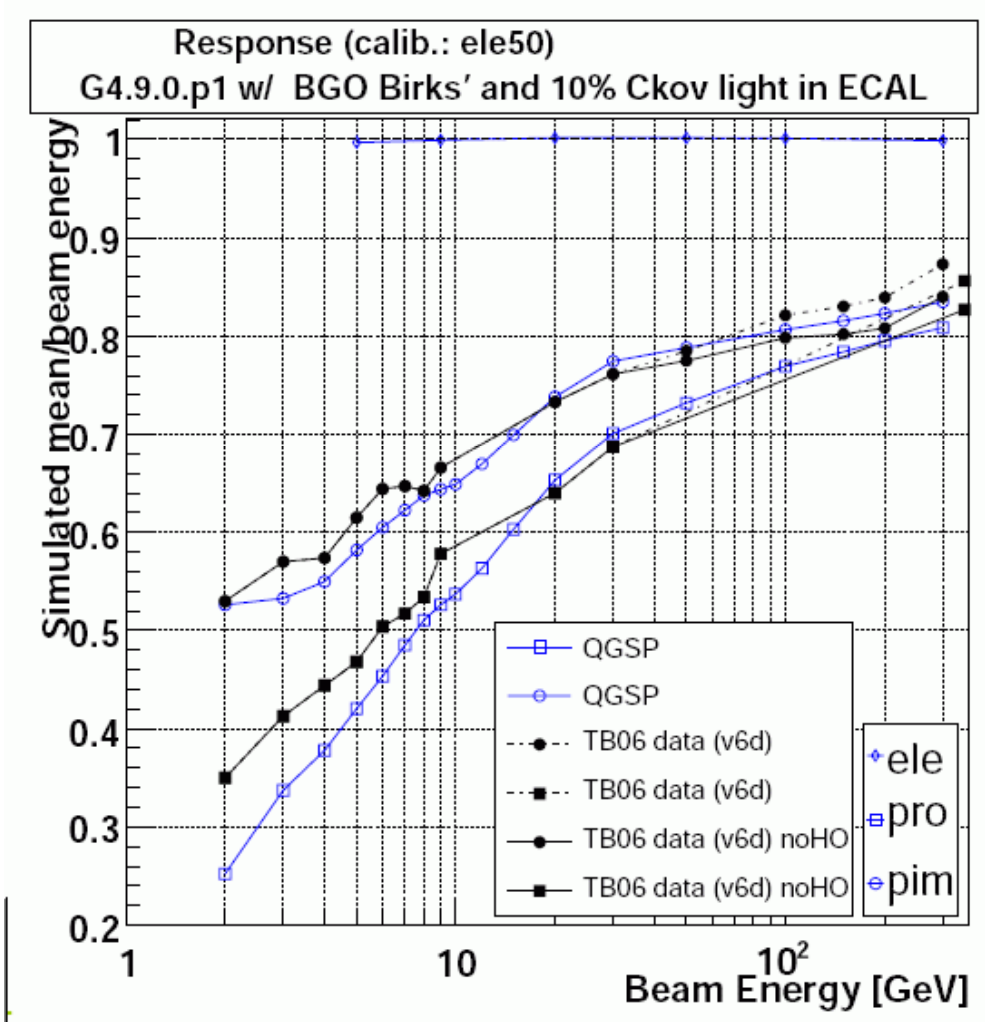
Simulated detector response can vary significantly depending on the physics model (*physics list*) used

Need better understanding and improvements to the models as well as a careful treatment of how the energy deposit is converted to light

Results were reported to GEANT4 development team

Does not include beam cleanup

Improved Agreement

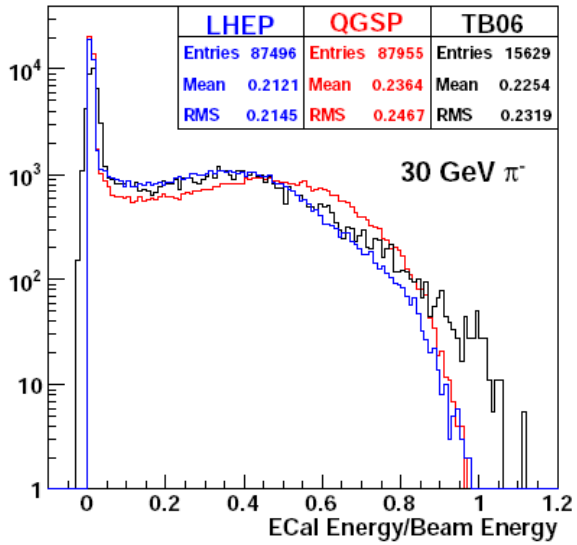


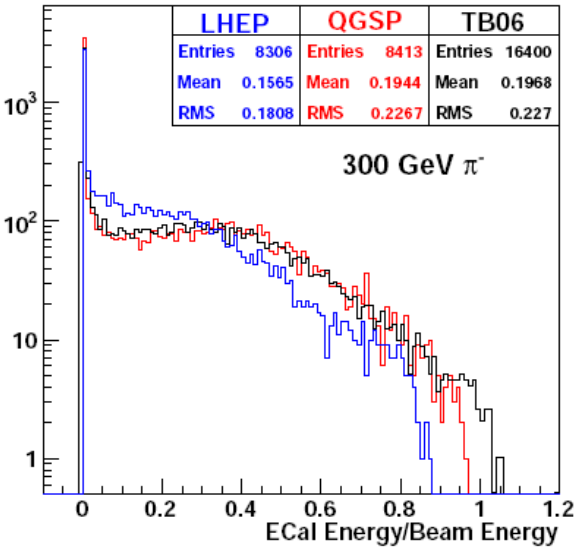
Includes saturation effects (Birk's Law) in scintillators

Finite contribution of Cherenkov photons in ECAL response

Includes beam cleanup to reduce instrumental effects

Still Room for Further Improvements

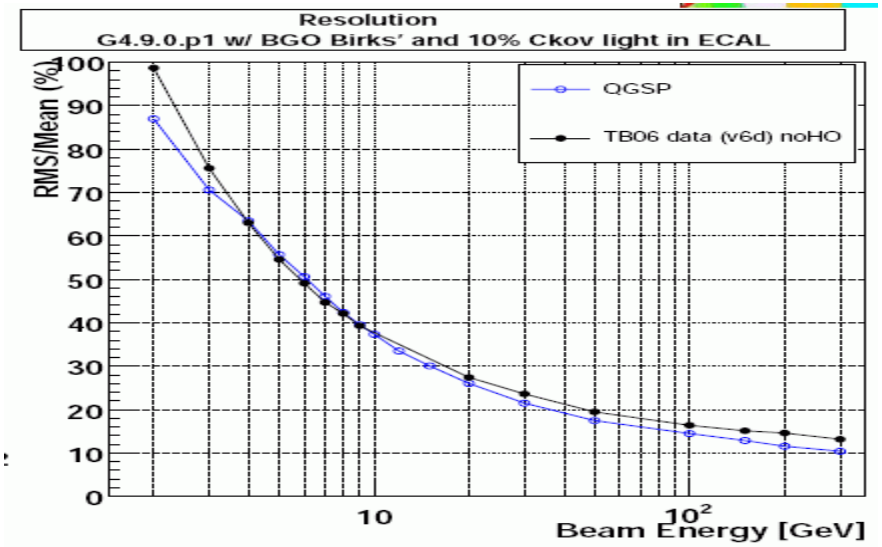




Response still disagrees 4-5% (outside of systematic error)

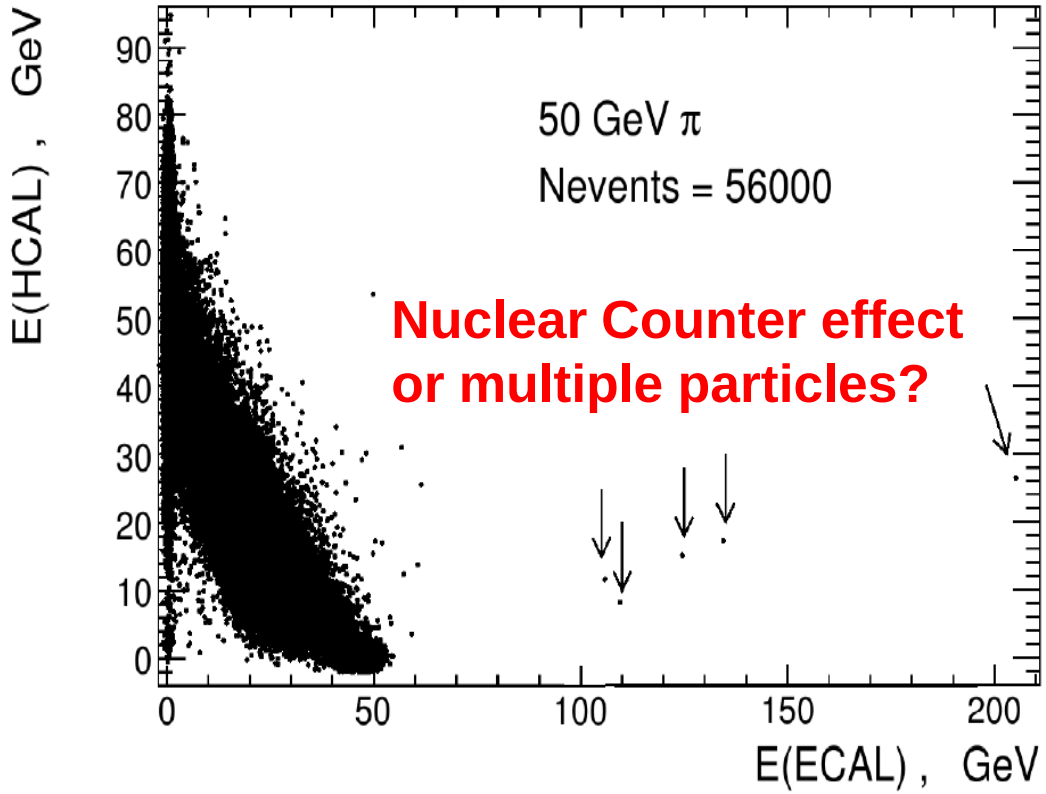
No single G4 model can reproduce energy fraction in ECAL at all energies

Default physics list in CMSSW: QGSP



Detector Effects

2006 pion Test Beam data has rare events (1 in 10000) with large response in the ECAL



Also, sometimes see a large signal in HF

Particles from late showers sometimes produce a large signal in HF

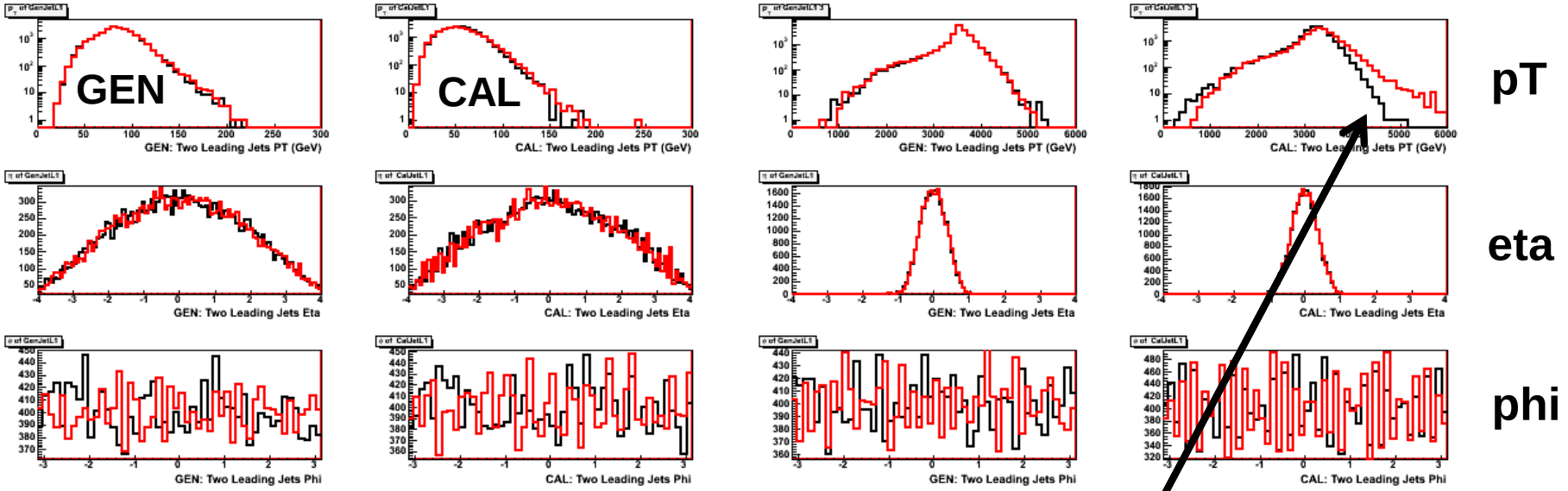
Due to Cherenkov light produced in the PMT window

- ***Develop filters to suppress these events***
- ***Study bias by simulating these rare events***

FastSim vs FullSim

QCD pthat = 80-120 GeV

QCD pthat = 3500 – inf GeV



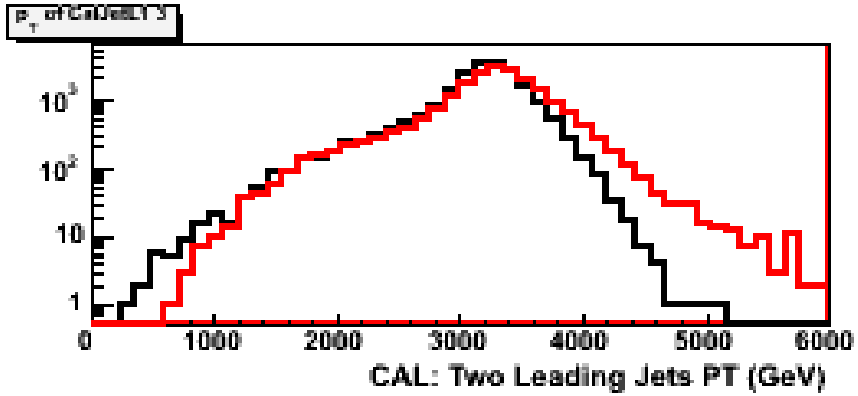
Good agreement for low pT

See that fastsim yields jets with higher pT compared with fullsim

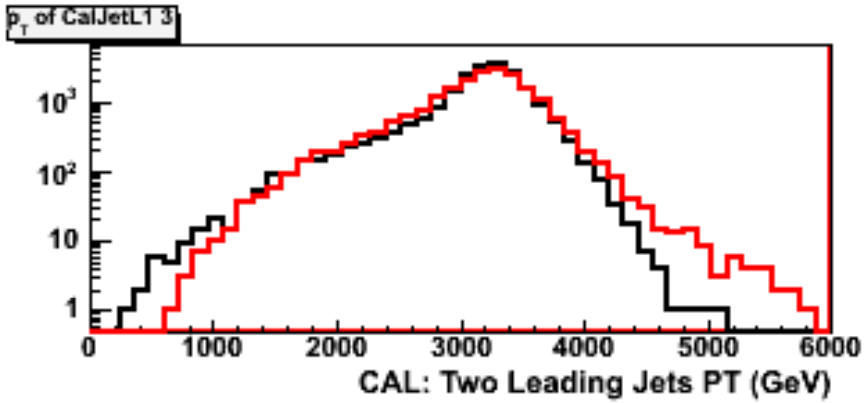
Saturation in FastSim

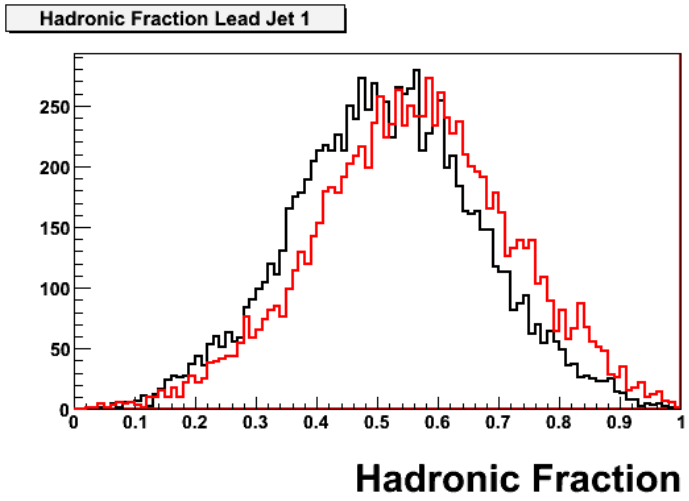
Saturation can easily be tuned via a configuration file

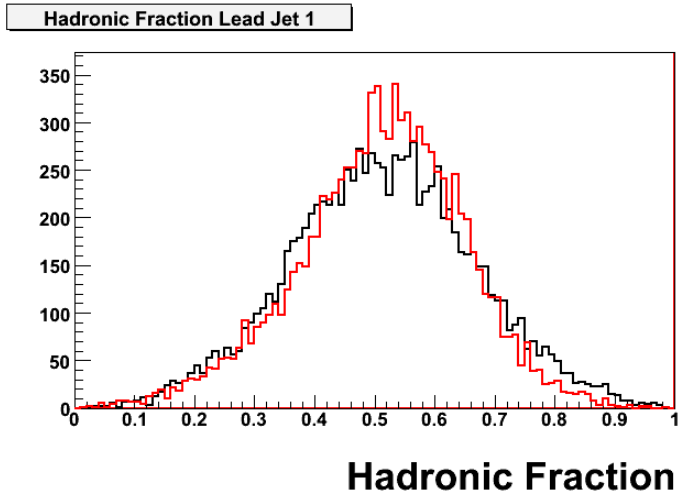
No Saturation



With Saturation: Saturation HB =1500

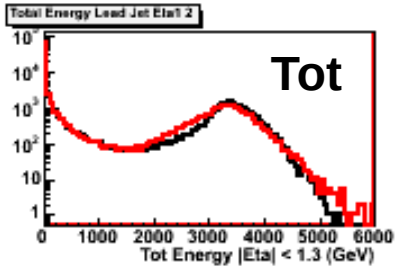


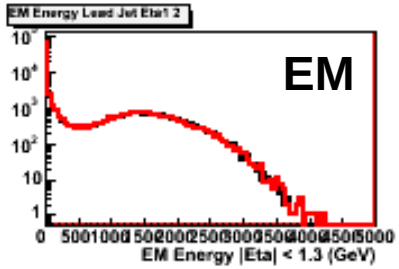


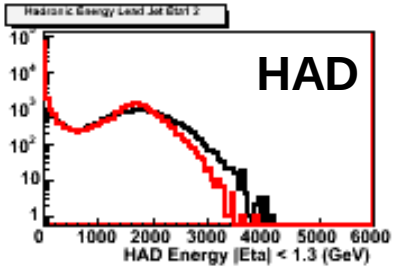


FastSim vs FullSim

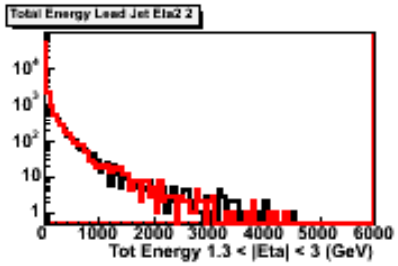
Saturation HB = 1300

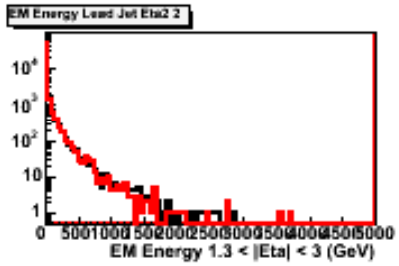


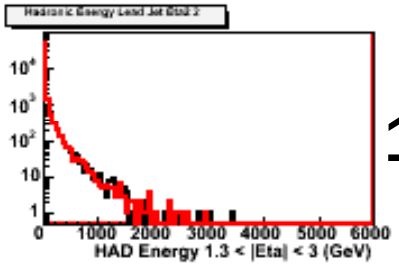




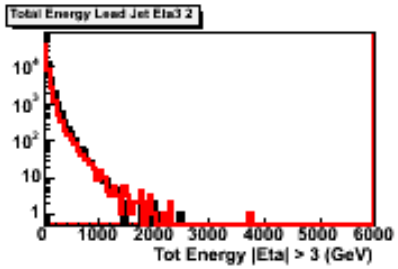
|eta| < 1.3

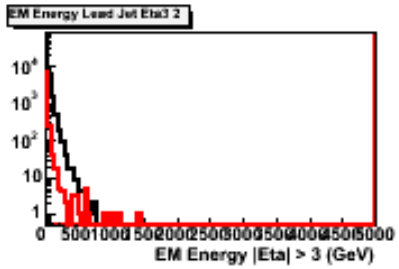


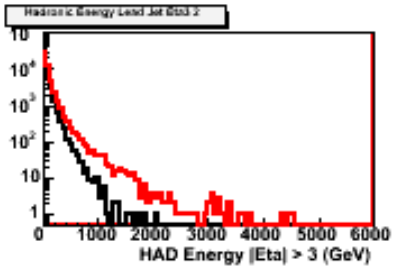




1.3 < |eta| < 3.0







|eta|>3.0

Total energy is well described, EM/HAD ratio not well described in forward region

Conclusions

Continue to use Test Beam (and global run) data to tune the full simulation *(simulation of test beam geometry)*

Tune FastSim to FullSim

Understand handles available to tune the physics models

Ensure triggers are in place to use real data for further tuning

Be ready to react quickly as the real data becomes available

Ensure necessary features are available in both fastsim and fullsim

- ***mixing events***
- ***pileup***